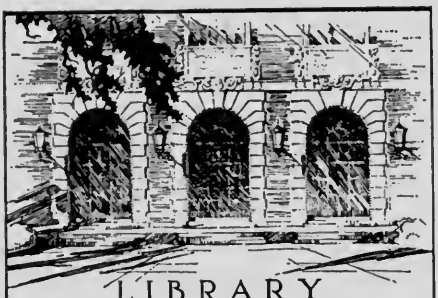

Breeding Two New Varieties of Greenhouse Tomatoes Resistant to Fusarium Wilt

By Walter A. Huelsen
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The New Varieties Ready for Market

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SUMMARY

THE MOST important disease affecting tomatoes grown in Illinois greenhouses is Fusarium wilt. In an effort to overcome this difficulty growers have resorted to the use of resistant field varieties, but these have not proved entirely successful under glass. For this purpose Marglobe is more widely used than any other resistant variety and seems to be the one best adapted. In the cloudy weather and short days of late fall and early winter, Marglobe, however, fails to pollinate well and the yields are often seriously reduced.

The authors have attempted to overcome these defects by breeding wilt-resistant varieties that are especially adapted to greenhouse conditions. Good results have been obtained by combining certain varieties that are wilt-resistant with the Grand Rapids Forcing variety, which is noted for its ability to blossom freely and to set fruits under adverse conditions.

The outcome of these investigations is the development of two distinct varieties that are ready for commercial use and have been named BLAIR FORCING and LLOYD FORCING by the investigators. Evidence has been presented herein which shows that both these varieties are wilt-resistant and have the ability to fertilize and mature fruits in late fall and in winter under conditions where yields of resistant field varieties are seriously impaired. The yields of spring and early summer crops have also compared very favorably with those of the best field varieties.

In addition to their yielding ability Blair Forcing and Lloyd Forcing have a desirable type and size of fruit which has proved acceptable in several markets. These varieties are also characterized by earliness of maturity and a picking season that is relatively short as compared with Marglobe.

The authors conclude from these investigations and from observations on several commercially grown crops that Blair Forcing and Lloyd Forcing tomatoes may be used very profitably by greenhouse growers.

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Breeding Two New Varieties of Greenhouse Tomatoes Resistant to Fusarium Wilt

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TOMATOES, lettuce, and cucumbers are undoubtedly the three major vegetable crops grown in Illinois greenhouses. Many growers consider tomatoes of greater importance than the two other crops and at the same time considerably more profitable owing to the fact that they seem able to compete much more successfully with the southern-grown product. Many growers are now raising both fall and spring crops of tomatoes in the same house. Such intensification has naturally brought to the fore a number of problems which those interested in the business wish to have solved.

The increasing occurrence of tomato wilt (*Fusarium lycopersici* Sacc.) has caused considerable concern. Such favorite varieties as Globe, Bonny Best, Grand Rapids Forcing, Comet, and others, together with a host of strains selected for years by individual greenhousemen, succumb more or less rapidly to the wilt disease, especially in the spring on account of higher soil temperature then. Growers have attacked this problem of their own accord in two general ways: they have sterilized their soils with live steam by a number of different methods of varying efficiency; and they have attempted to use resistant varieties, hoping to avoid the necessity of steam sterilization.

Sterilization usually affords protection for only a single crop. While theoretically the organism should be eliminated entirely by this method, the fact is that sterilization is scarcely ever complete, and reinfestation is therefore only a matter of time. The chief objections to steam sterilization are usually the lack of equipment necessary to do it thoroly and the expense involved.

Scarcely any growers have been satisfied with the results they have had in trying to use resistant varieties of tomatoes. Marglobe, developed by Dr. F. J. Pritchard of the U. S. Department of Agriculture, has been used most frequently, but it often sets fruits rather poorly under greenhouse conditions, especially in late fall, and ripens slowly. Altho meeting with marked success outdoors, Marglobe is not entirely suitable for greenhouse use under conditions in Illinois.

PURPOSE OF EXPERIMENTS

The investigations reported herein were confined to an attempt to breed a variety of tomato that would be resistant to wilt and at the same time pollinate readily under the conditions prevailing in the greenhouse. There have always been a large number of good greenhouse varieties which set readily, but all of them are more or less susceptible to wilt. Before embarking upon a program of this kind, preliminary experiments were planned in order to determine the yielding ability under glass of some of the more promising wilt-resistant varieties. These data were used as a guide in subsequent crossing and selection.

A great deal of excellent tomato breeding work in the direction of wilt-resistance has been accomplished, but this is not particularly pertinent here because it was directed toward the breeding of field varieties. Only one wilt-resistant variety especially bred for greenhouse purposes is known to the authors. This variety is the Invincible, bred by McWhorter and Parker[11, 12*] from a cross between Marvel and Bonny Best.

PRELIMINARY TESTS OF PROMISING VARIETIES

Materials.—The early investigations (1926) consisted of a comparison in the greenhouse of selections from the more promising wilt-resistant varieties. These selections had been made during the summer of 1925 out of the best-yielding varieties in a field test.[a] Owing to their good yields and other qualities the resistant varieties, Louisiana Red, Louisiana Pink, Marglobe, and Marvana, were chosen as being most suitable for the purpose of the experiment. Seed of the two Louisiana varieties had been contributed originally by Dr. C. W. Edgerton of the Louisiana Experiment Station. Marglobe and Marvana were furnished by Dr. Fred J. Pritchard of the U. S. Department of Agriculture. Grand Rapids Forcing and Bonny Best were purchased from commercial sources.

Location of the Experiments.—Some of the preliminary experiments, together with the breeding experiments proper, were conducted at Urbana in a small greenhouse equipped with raised benches beneath which were located the heating coils. This arrangement provided a high soil temperature. Consequently the wilt became almost always extremely virulent after the experiments had progressed a year. Previous to this the soil had been sterilized before planting each crop.

[a]Discussed in Ill. Agr. Exp. Sta. 39th Ann. Rpt., 162. 1926.

Physiological Strain of Fusarium.—The strain of *Fusarium lycopersici* Sacc. came from Union county, Illinois, having been introduced in soil samples used in the course of thesis work by a graduate student. Having once gained a foothold it spread rapidly thruout the greenhouses and the Urbana farm. Varieties such as Grand Rapids Forcing, Bonny Best, and Comet nearly always were heavily infected.

FIG. 1.—LEAF TYPE AND CHARACTERISTIC CLUSTER OF BOTH BLAIR FORCING AND LLOYD FORCING

Growing Conditions.—The soil was manured and fertilized previous to planting each crop but was not sterilized. In fact the aim was to create conditions as favorable as possible for the organism.

Rather careful plot technic was required thruout the experiments in order to determine the resistance of each progeny. The bench greenhouse mentioned previously is built with its axis running east and west. Therefore, in winter the east half of the house is always considerably warmer than the west half because of prevailing westerly winds.

Soil temperatures are known to exert an important influence on the growth of Fusarium and its toxicity to the plant. Clayton[3]* has shown a temperature of 28° C. to be most favorable for the development of the organism, while Haymaker[6]* states that the excretory products from cultures grown at 28° C. are more toxic to the plant than those

produced at other temperatures. The maintenance of a soil temperature of 28° C. was desirable, therefore, from the standpoint of determining relative wilt-resistance. This proved to be impossible except at the eastern end of the greenhouse. Accordingly, the plots were always distributed with this point in view. Unfortunately, however, during warm, sunshiny days, the soil temperatures at the eastern end of the

FIG. 2.—LEAF TYPE AND CHARACTERISTIC CLUSTER OF MARGLOBE
This photograph was taken on the same date as Fig. 1. Note difference in maturity.

greenhouses often rose above 30° C., thus causing an unbalanced physiological condition in the plants, which rendered them more susceptible to the action of the toxic products mentioned by Haymaker.[6]* Apparently this was the reason most of the resistant plants mentioned later succumbed to wilt at the eastern ends of the benches but proved entirely resistant everywhere else. However, special attention was always given plants surviving at the eastern ends of the benches.

Arrangement of Plots and Technic.—Duplicate plots containing 10 plants each were set in the greenhouse benches in March, 1926. The plants in this bench test were spaced 18 by 20 inches. The soil was infested with wilt, as already described. A check plot of Bonny Best, a variety very susceptible to wilt, was planted adjacent to each resistant selection.

The plants in this and in all the later bench experiments were trained to a single stem and headed back at 70 inches, the maximum permissible owing to the structure of the house. Plants as short as these account for the somewhat low yields.

Method of Pollination.—Bouquet[1, 2*] and Schneck[14*] have shown that hand methods of pollination are greatly superior to any other, but of course involve considerably greater expense. In considering the method of pollination to use in these experiments, the authors believed that simply jarring the plants would demonstrate much better than any other method the inherent fertilizing ability of each strain. Accordingly, the plants were simply tapped lightly each day with a stick.

Method of Grading.—The fruits were picked when ripe and divided into three grades. "Firsts" consisted of the largest and smoothest tomatoes free from cracks and blemishes. "Seconds" were usually somewhat smaller than firsts but there were also included in this grade large-sized fruits which were blemished, cracked, or irregular. "Culls" consisted of unmarketable fruits, chiefly so because of small size. In some of the later experiments "seconds" and "culls" were combined. Thruout this bulletin, where yields are mentioned the weights of "firsts" are meant unless other grades are stated.

Results of First Preliminary Experiment

The data for the crop grown in the spring of 1926 are given in Table 1. The susceptible variety, Bonny Best, outyielded all the resistant varieties except Marglobe in spite of a severe infection of wilt. In this instance Bonny Best matured the major part of its crop before the wilt disease curtailed the yield very severely. This also occurs outdoors, as shown by Edgerton[4*] in the case of very early varieties such as Earliana and June Pink. Bonny Best, however, is usually somewhat later than these varieties and the grower cannot always be certain of securing a good yield before the plant succumbs to the disease. This hazard makes Bonny Best an unreliable variety for the grower to use in wilt-infested greenhouses.

With the exception of Marvana the fruits of the different varieties did not differ very much in size (Table 2). Marglobe produced the largest percentage of firsts and the smallest percentage of seconds and culls. Louisiana Red and Marvana produced the smallest percentage of firsts and the largest of seconds and culls. The most desirable varieties, according to the results shown in Table 2, were Marglobe, Louisiana Pink, and Bonny Best.

TABLE 1.—MEAN YIELDS OF FOUR WILT-RESISTANT VARIETIES OF TOMATOES COMPARED WITH ADJACENT CHECK PLOTS OF SUSCEPTIBLE BONNY BEST: SPRING OF 1926

(Calculated to a basis of 10 plants)

Variety	Firsts		Seconds		Culls	
	No.	*oz.*	*No.*	*oz.*	*No.*	*oz.*
Louisiana Pink	70	376	24	85	12	36
Bonny Best check	93	503	42	156	30	64
Increase over check	−23	−127	−18	−71	−18	−28
Louisiana Red	68	352	34	112	24	58
Bonny Best check	92	504	34	128	13	34
Increase over check	−24	−152	0	−16	11	24
Marglobe	101	580	30	93	10	20
Bonny Best check	66	378	25	102	10	26
Increase over check	35	202	5	−9	0	−6
Marvana	82	392	45	157	31	68
Bonny Best check	90	538	36	151	20	60
Increase over check	−8	−146	9	6	11	8

TABLE 2.—MEAN SIZE OF FRUITS AND PERCENTAGE OF EACH GRADE OBTAINED FROM FOUR WILT-RESISTANT VARIETIES OF TOMATOES: SPRING OF 1926

Variety	Mean size of fruits			Percentage of total yield in each grade		
	Firsts	Seconds	Culls	Firsts	Seconds	Culls
	oz.	*oz.*	*oz.*			
Louisiana Pink	5.4	3.5	3.2	75.6	17.1	7.3
Louisiana Red	5.2	3.3	2.4	67.4	21.4	11.2
Marglobe	5.7	3.2	1.9	83.6	13.4	2.9
Marvana	4.8	3.5	2.2	63.5	25.4	11.1
Bonny Best checks	5.5	3.9	2.6	73.9	19.4	6.7

TABLE 3.—PERCENTAGE OF TOTAL CROP OF FIRST-GRADE FRUITS MATURED BY FOUR WILT-RESISTANT VARIETIES OF TOMATOES DURING HARVEST OF SPRING CROP OF 1926[1]

Variety	May 11-20	May 21-30	May 31-June 9	June 10-19	June 20-29	June 30-July 9	July 10-19
Louisiana Pink	2.7	17.5	40.8	22.6	12.3	2.6	1.5
Louisiana Red	8.2	23.0	32.6	20.3	13.6	1.6	.7
Marglobe	2.0	8.6	36.0	21.9	20.2	3.8	7.5
Marvana	1.4	23.9	44.1	15.5	13.1	1.0	1.0
Bonny Best checks	2.9	20.4	30.7	20.7	14.4	7.0	3.9

[1]Total percentage harvested = 100.

Marvana was the earliest variety, having produced 84.9 percent of the total crop up to June 19 (Table 3). Louisiana Red and Pink were both on a par and practically as early as Marvana. Bonny Best was somewhat earlier than Marglobe.

Results of Second Preliminary Experiment

A second and more extensive experiment was started in the summer of 1926. Seed was sown July 20 and transplanted to the houses Sep-

tember 1. One series was planted in a ground-bed house used for fruit-breeding work, where the soil was free from wilt. A second series was planted in the same benches as the first experiment, the soil not being sterilized. Each series was replicated four times and planted in such a way that a Grand Rapids Forcing check was adjacent to one side and a Bonny Best check to the other. The series on infested soil was planted 22 by 25 inches and the wilt-free series 24 by 26 inches. Each plant was pruned to a single stem.

TABLE 4.—MEAN YIELDS OF THREE WILT-RESISTANT VARIETIES OF TOMATOES AND TWO SUSCEPTIBLE VARIETIES, ON INFESTED AND ON WILT-FREE SOILS

Variety	Weight of fruit per plant				Number of fruits per plant			
	Firsts	Seconds	Culls	Total	Firsts	Seconds	Culls	Total
Fall crop of 1926 on wilt-infested soil								
	oz.	oz.	oz.	oz.				
Louisiana Pink	38.8	4.6	1.0	44.4	9.6	2.0	1.0	12.6
Marvana	31.8	4.0	1.4	37.2	9.2	1.6	.8	11.6
Marglobe	46.6	3.3	.8	50.7	10.6	1.4	.6	12.6
Bonny Best checks	23.5	4.0	1.7	29.2	6.4	1.6	.9	8.9
Grand Rapids checks	31.0	10.1	5.3	46.4	11.7	5.2	4.5	21.4
Fall crop of 1926 on wilt-free soil								
Louisiana Pink	48.5	.9	.9	50.3	11.4	.4	.5	12.3
Marvana	32.0	6.7	3.8	42.5	9.2	2.3	2.6	14.1
Marglobe	41.1	2.8	.9	44.8	10.0	1.4	.8	12.2
Bonny Best checks	41.8	5.2	2.1	49.1	11.0	2.0	1.2	14.2
Grand Rapids checks	35.0	11.6	7.2	53.8	14.2	6.4	6.4	27.0

On infested soil Bonny Best gave the lowest and Marglobe the highest yield (Table 4). On wilt-free soil Marglobe and Bonny Best yields were practically the same, and the yield of Lousiana Pink was considerably higher. This increase in the yield of Louisiana Pink was due to the fact that in the wilt-free series ground beds were used and the plants were headed at a height of 7½ feet. Louisiana Pink, with a long, straggly vine, accordingly yielded much better than on the benches where it was headed at 70 inches. Marvana, a short-growing variety, was not affected at all, and gave practically equal yields in both houses.

CHARACTERISTICS OF VARIETIES SELECTED FOR BREEDING

The 1926 tests enabled the authors to make a fairly comprehensive study of the characteristics of each variety under greenhouse conditions.

Grand Rapids Forcing was outstanding in the number of tomatoes matured. This variety on wilt-infested soil matured a total of 21.4 fruits per plant, compared with 12.6 per plant in the case of Louisiana Pink and Marglobe, the two next highest. On wilt-free soil the differences were just as large (Table 4). In size of fruits Grand Rapids Forcing was much smaller than any other variety (Table 6). Louisiana Pink produced the largest fruits in the wilt-free series and Marglobe ranked first in the wilt-infested series. Bonny Best and Marvana were somewhat mediocre in performance.

TABLE 5.—PERCENTAGE OF TOTAL CROP MATURED BY THREE WILT-RESISTANT VARIETIES OF TOMATOES IN EACH FIFTEEN-DAY PERIOD DURING HARVEST OF FALL CROP OF 1926[1]

Variety	Oct. 15-30	Nov. 1-15	Nov. 16-30	Dec. 1-15	Dec. 16-31	Jan. 1-15
Fall crop of 1926 on wilt-infested soil						
Louisiana Pink	5	12	31	29	21	2
Marvana	12	24	26	23	15	..
Marglobe	4	23	26	13	28	6
Bonny Best checks	26	26	27	9	11	1
Grand Rapids checks	7	26	30	20	13	4
Fall crop of 1926 on wilt-free soil						
Louisiana Pink	1	8	21	41	28	1
Marvana	3	21	19	22	33	2
Marglobe	2	15	25	23	31	4
Bonny Best checks	6	19	32	19	23	1
Grand Rapids checks	1	16	33	20	25	5

[1]Total percentage harvested = 100.

TABLE 6.—MEAN SIZE OF FRUITS OF EACH GRADE HARVESTED FROM EACH VARIETY OF TOMATO GROWN IN FALL OF 1926

Variety	On wilt-infested soil			On wilt-free soil		
	Firsts	Seconds	Culls	Firsts	Seconds	Culls
	oz.	oz.	oz.	oz.	oz.	oz.
Louisiana Pink	4.05	2.30	1.00	4.25	2.25	1.80
Marvana	3.46	2.50	1.75	3.48	2.91	1.46
Marglobe	4.40	2.36	1.33	4.11	2.00	1.12
Bonny Best checks	3.67	2.50	1.89	3.80	2.60	1.75
Grand Rapids checks	2.65	1.96	1.18	2.46	1.81	1.12

In addition to producing small fruits, Grand Rapids Forcing proved to have a rather small, slow-growing vine. It was exceeded in earliness only by Bonny Best in both series (Table 5).

Marvana equaled Grand Rapids Forcing in earliness in one series (Table 5) and was slightly later in the other. In yield the two varieties were about the same (Table 4), but in mean size of fruits Marvana was larger (Table 6).

Marglobe is too well known to require much comment. It yielded well under all conditions and was somewhat earlier than Louisiana Pink. In size of fruit it was about the same as Louisiana Pink. Marglobe set an average number of fruits.

Grand Rapids Forcing, Marvana, and Marglobe are orange-red fruited while Louisiana Pink has a colorless epidermis of the type described by Lindstrom[8, 9]* and red flesh. For that reason it gives the illusion of being pink, while in reality this difference in color is due to the absence in the epidermis of the carotinoid pigment described by Howard.[7]* Louisiana Pink is a rapid-growing variety with a long, straggly vine, the clusters being rather far apart. It is always the first variety to require heading. It is slightly later than Marglobe and has good-sized fruit. It is only average in the number of fruits matured.

Louisiana Pink, Marvana, and Marglobe are all wilt-resistant and Grand Rapids Forcing partially so. Bonny Best is susceptible, and for that reason was discarded as being unsuitable for the breeding tests.

Louisiana Pink, Marvana, and Grand Rapids Forcing are all more or less oblate in shape. On the other hand, Marglobe is deeply oblate to spherical. In the crosses which were made as described later, the aim was to self in the F_2 generation plants with spherical fruits similar to Marglobe, as this shape is very popular. This proved to be rather difficult owing to the fact that in crosses of oblate by spherical types, the spherical shows a lack of dominance, according to Lindstrom.[10]*

CROSSES MADE

Six crosses were made on the crop grown in infested soil during the fall of 1926 as follows:

No. 1000 Marglobe Strain 1-2 X Grand Rapids Forcing
No. 1001 Marglobe Strain 1-2 X Grand Rapids Forcing
No. 1002 Marvana Strain 3-17 X Grand Rapids Forcing
No. 1003 Marvana Strain 3-17 X Grand Rapids Forcing
No. 1004 Louisiana Pink Strain 10-63 X Grand Rapids Forcing
No. 1005 Louisiana Pink Strain 10-63 X Grand Rapids Forcing

Grand Rapids Forcing was used as the male parent in all the crosses. The three resistant varieties were not intercrossed, as none of them possessed the desirable character of fertilizing well in the greenhouse.

The F_1 progenies were grown on the benches in replicated plots during the spring of 1927. A large number of plants were self-pollinated but seeds were saved only from those which appeared to be most resistant to wilt.

A large number of F_2 progenies were grown in the fall of 1927. Yield records consisting of number and weight of fruits and the percentage of defective fruits were taken. As expected, there was considerable segregation both as to resistance and as to horicultural characters. Two of the most promising individuals were selected out of each cross on the basis of yield, small percentage of defective fruits, size of fruits, uniformity, and general appearance.

The F_3 and F_4 generations were planted in the same greenhouse in the spring and fall, respectively, of 1928, and the procedure followed was in all respects identical with that described for the F_2 progeny.

The F_5 generation planted in the spring of 1929 was tested more elaborately, and copious notes were kept. This test was supplemented by a strain test on a much larger scale, planted in ground beds in another greenhouse where the soil infestation was considerably milder than in the bench greenhouse. The data from these tests are not given here, being of value mainly in the work of selection. It will be sufficient to say that the F_5 inbred lines performed very creditably.

The F_6 generation was planted in the fall of 1929 on the same benches and selected as described above. Selection work was continued with the F_7 generation in the spring of 1930 and in addition, crosses were made between the more promising lines.

TWO PROMISING VARIETIES DEVELOPED

Lloyd Forcing

The first strain to show considerable promise was a selection out of cross No. 1004 (Louisiana Pink and Grand Rapids Forcing). This cross was still segregating for pink fruits in the F_3 generation, but a red-fruited selection continued to breed true for color in the F_4, F_5, F_6, and F_7 generations.

Since this selection is quite different in its characters from other known varieties, the authors have named it LLOYD FORCING in honor of Dr. J. W. Lloyd, of the Department of Horticulture at this Station.

Lloyd Forcing is a rapid and vigorous grower having a large vine of the Louisiana Pink type. It sets blossoms very freely and has the pollination characteristics of Grand Rapids Forcing. The fruit is oblate, smooth, and solid. It keeps very well and has not cracked in any of the greenhouse tests. The color is a solid red without green streaks at the stem end, nor is it subject to yellow blotches. It clings to the vine unusually well and is rather difficult to pick, probably owing to

the fact that the abscission layer in the pedicel does not develop sufficiently early. This character prevents the premature dropping of partly ripened fruit, which is so annoying to the grower, but on the other hand makes it difficult to preserve the calyx still attached to the fruit. To some growers this might be a serious objection if they desire to market the fruit with calyx attached, as demanded by several markets.

FIG. 3.—RELATIVE GROWTH OF BLAIR FORCING AND LLOYD FORCING BEFORE HEADING AS COMPARED WITH MARGLOBE

The two smaller rows in the center are Marglobe. The taller rows on the left and right are respectively Blair and Lloyd Forcing.

Lloyd Forcing is as wilt-resistant as Marglobe under the greenhouse conditions of these experiments. It is not particularly susceptible to the physiological condition known as blossom end rot.

Lloyd Forcing was tested in a mildly infested ground-bed greenhouse in the fall of 1929. The results are given in Table 7. No attempts were made to pollinate other than to tap the plants once a day.

Lloyd Forcing yielded more than twice as much as Grand Rapids Forcing and 50 percent more than Marglobe. In average size of fruit it was slightly larger than Marglobe. According to the data in Table 8, Lloyd Forcing is a trifle earlier than Marglobe and somewhat later than Grand Rapids Forcing.

A statistical study in some respects like Myers'[13]* was made of the Lloyd Forcing variety from the crop planted in the fall of 1929. The means, differences, and coefficients of variability are shown in Table 9.

TABLE 7.—YIELD OF LLOYD FORCING IN FALL OF 1929 COMPARED WITH YIELDS OF TWO OTHER VARIETIES[1]

Picking season in 10-day periods	Yield of marketable tomatoes per plant			
	Grand Rapids Forcing	Lloyd Forcing	Livingston's Marglobe	Lloyd Forcing
	oz.	oz.	oz.	oz.
Nov. 5-14	3.15	1.80	2.35	1.74
Nov. 15-24	11.42	14.74	10.42	15.96
Nov. 25-Dec. 4	12.56	31.28	12.44	23.64
Dec. 5-14	.86	4.31	3.97	10.92
Dec. 15-24	3.73	7.96	7.20	9.64
Dec. 25-Jan. 3	3.83	11.49	6.94	11.41
Jan. 4-13	2.79	6.44	6.94	6.29
Total yield per plant	38.34	78.02	50.26	79.60
Average size of fruits	2.10	3.07	2.94	3.26

[1]A plot of Lloyd Forcing was planted on each side of the Grand Rapids Forcing and the Livingston's Marglobe plots. Each plot contained 66 plants trained to single stems and planted 32 by 16 inches on soil infested with Fusarium wilt. The means of the Lloyd Forcing plots include 132 plants and those of the other two varieties 66 plants each.

TABLE 8.—RELATIVE MATURITY OF DIFFERENT VARIETIES OF TOMATOES IN YIELD TEST DURING FALL OF 1929

(Percentage of total crop picked in each 10-day period)

Picking season in 10-day periods	Grand Rapids Forcing	Lloyd Forcing	Livingston's Marglobe	Lloyd Forcing
Nov. 5-14	8.22	2.31	4.68	2.19
Nov. 15-24	29.79	18.89	20.73	20.05
Nov. 25-Dec. 4	32.76	40.09	24.75	29.70
Dec. 5-14	2.24	5.52	7.90	13.72
Dec. 15-24	9.73	10.20	14.33	12.11
Dec. 25-Jan. 3	9.99	14.73	13.81	14.33
Jan. 4-13	7.28	8.25	13.81	7.90

Lloyd Forcing is taller and grows more vigorously and rapidly than either Grand Rapids Forcing or Marglobe, as shown by comparing the respective mean heights before pruning. Lloyd Forcing is also somewhat more variable in height than the other two varieties, as shown by the slightly larger coefficient of variability.

Grand Rapids Forcing sets the first cluster nearest the ground, as may be noted by comparing the means of the distances between the ground and the first cluster. Marglobe is intermediate in this respect, and Lloyd Forcing sets the first cluster much higher. At the same time, Lloyd Forcing is much more variable than either of the other varieties.

A comparison of the stem diameters just above the second cluster shows Grand Rapids to be smallest, Lloyd Forcing intermediate, and Marglobe largest. The extreme mean difference, however, is less than 2 mm. In variability Lloyd Forcing is again the highest.

In Grand Rapids the clusters were much closer together. Marglobe and Lloyd Forcing were practically the same. Lloyd Forcing, however,

TABLE 9.—MEANS AND COEFFICIENTS OF VARIABILITY OF CERTAIN CHARACTERS IN LLOYD FORCING, MARGLOBE, AND GRAND RAPIDS FORCING TOMATOES

Variety	Mean	Difference	D / P. E.	Odds	Coefficient of variability	Difference	D / P. E.	Odds
Total height before pruning, inches								
A Marglobe	64.60 ± .370	B−A 1.96 ± .507	3.86	116:1	6.89 ± .404	A−B .62 ± .546	1.14	1.18:1
B Grand Rapids	66.56 ± .347	C−A 21.43 ± .481	44.55	∞	6.27 ± .368	C−A 1.72 ± .477	3.60	64.79:1
C Lloyd Forcing	86.03 ± .308	C−B 19.47 ± .464	41.96	∞	8.61 ± .253	C−B 2.34 ± .447	5.23	1350.35:1
Distance from ground to first cluster, inches								
A Marglobe	14.97 ± .121	A−B 2.45 ± .153	16.01	∞	9.72 ± .571	A−B .79 ± .775	1.02	1.00:1
B Grand Rapids	12.52 ± .093	C−A 3.85 ± .153	25.16	∞	8.93 ± .524	C−A 2.38 ± .675	3.52	53.95:1
C Lloyd Forcing	18.82 ± .094	C−B 6.30 ± .132	47.73	∞	12.10 ± .360	C−B 3.17 ± .636	4.98	1350.35:1
Stem diameter above second cluster, inches								
A Marglobe	15.44 ± .143	A−B 1.76 ± .186	9.46	∞	11.18 ± .664	A−B .73 ± .908	.80	<1.00:1
B Grand Rapids	13.68 ± .119	A−C .88 ± .164	5.36	∞	10.45 ± .620	C−A 2.20 ± .775	2.84	15.95:1
C Lloyd Forcing	14.56 ± .081	C−B .88 ± .144	6.11	∞	13.38 ± .400	C−B 2.93 ± .738	3.97	142.26:1
Aver. distance between clusters, inches								
A Marglobe	10.21 ± .071	A−B 1.45 ± .104	13.94	∞	8.40 ± .493	B−A 2.00 ± .790	2.53	9.89:1
B Grand Rapids	8.76 ± .076	C−A 1.01 ± .080	12.62	∞	10.40 ± .617	A−C .49 ± .545	.90	<1.00:1
C Lloyd Forcing	11.22 ± .037	C−B 2.46 ± .084	29.28	∞	7.91 ± .232	B−C 2.49 ± .659	3.78	95.15:1
Aver. number fruits per cluster per plant								
A Marglobe	3.53 ± .047	B−A 3.18 ± .099	32.12	∞	16.12 ± .970	A−B .55 ± 1.348	.41	<1.00:1
B Grand Rapids	6.71 ± .087	C−A 1.95 ± .062	31.45	∞	15.57 ± .936	C−A 1.34 ± 1.104	1.21	1.39:1
C Lloyd Forcing	5.48 ± .040	B−C 1.23 ± .096	12.81	∞	17.46 ± .527	C−B 1.89 ± 1.074	1.76	3.45:1
Number of fruits per plant								
A Marglobe	21.59 ± .308	B−A 22.65 ± .640	35.39	∞	17.21 ± 1.039	A−B 1.93 ± 1.386	1.39	1.90:1
B Grand Rapids	44.24 ± .561	C−A 14.41 ± .417	34.56	∞	15.28 ± .918	C−A 1.59 ± 1.186	1.34	1.63:1
C Lloyd Forcing	36.00 ± .281	B−C 8.24 ± .627	13.14	∞	18.80 ± .571	C−B 3.52 ± 1.081	3.26	37.46:1

was much less variable in this respect, as shown by the small coefficient of variability.

Grand Rapids had a mean of 6.71 fruits per cluster and Lloyd Forcing, 5.48. Marglobe set fewer fruits, having a mean of only 3.53 per cluster. The coefficients of variability are essentially the same.

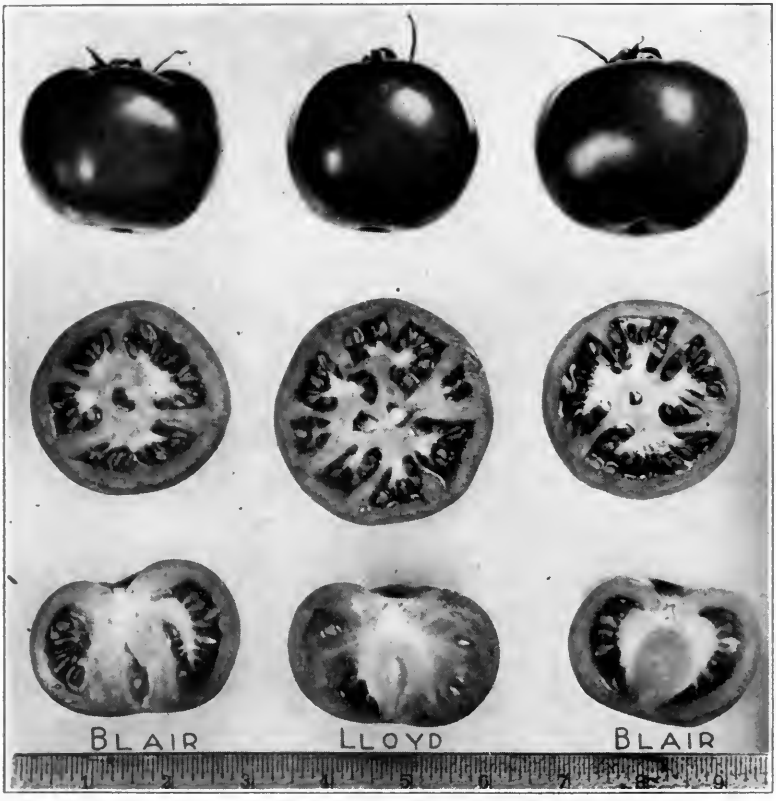

FIG. 4.—FRUIT OF BLAIR FORCING AND LLOYD FORCING

Both varieties are smooth and slightly flattened in shape. In cross-section they are solid, with rinds sufficiently thick to withstand shipment. The longitudinal sections show their solidity and small cores. The ruler shows the comparative size of the varieties.

Grand Rapids averaged 44.24 fruits per plant, Lloyd Forcing 36.00 and Marglobe only 21.59. The coefficient of variability for Lloyd Forcing is somewhat higher than for the other two varieties.

In general Lloyd Forcing proved to be somewhat more variable than either Marglobe or Grand Rapids. Marglobe was more variable

than Grand Rapids but the differences lacked significance. The greater variation in Lloyd Forcing and Marglobe is most likely due to the hybrid origin of the two varieties. Lloyd Forcing was more variable than Marglobe in only two out of five observations, but as compared with Grand Rapids it proved to have a larger variation four times out of five.

Blair Forcing

This variety originated from the same cross as Lloyd Forcing and is a pink selection made in the F_3 generation. It has bred true for pink fruit color in the F_4, F_5, F_6, and F_7 generations. It is essentially the same type as Lloyd Forcing in vine and general fruit characters, but owing to the fact that its color is pink compared with the red of Lloyd Forcing, the authors have decided that it is sufficiently distinct to be introduced as a separate variety. It has been named BLAIR FORCING in honor of Dr. J. C. Blair, head of the Department of Horticulture at this Station.

Blair Forcing has the same tall-growing vine as Lloyd Forcing and sets fruits just as readily. A comparison of the performance of the two varieties in the bench greenhouse on soil heavily infested with Fusarium wilt is shown in Table 10. This crop was planted in the fall of 1929 and the plots were replicated in three series.

In all three series Blair Forcing showed a slight tendency to produce a greater number of fruits per plant. The odds, however, are too small to be of any significance. In total weight of fruit produced per plant, Blair Forcing outyielded Lloyd Forcing slightly in two of the three series. The average size of the fruits of Blair Forcing was slightly larger than Lloyd Forcing twice out of three times.

In wilt-resistance Blair Forcing proved appreciably better than Lloyd Forcing. The results of the wilt counts were as follows:

Series 1
Blair Forcing, 16 percent wilted
Lloyd Forcing, 67 percent wilted (50 percent of these died)

Series 2
Blair Forcing, 12 percent wilted
Lloyd Forcing, 25 percent wilted (25 percent of these died)

Series 3
Blair Forcing, 25 percent wilted
Lloyd Forcing, 38 percent wilted

None of the Blair Forcing plants, it should be noted, were infected heavily enough to cause the death of the plant, but in the case of Lloyd Forcing a considerable number died. These results should not lead to the conclusion that these varieties have a low resistance. As a matter

TABLE 10.—YIELDS OF LLOYD FORCING AND BLAIR FORCING TOMATOES IN BENCH GREENHOUSE ON SOIL HEAVILY INFESTED WITH FUSARIUM WILT: FALL OF 1929

Series	Variety	Total number of fruits per plant										
		1	2	3	4	5	6	7	8	Mean	Difference	Odds
1	Blair Forcing	17	16	21	8	19	24	....	....	17.5	1.7	1.97:1
	Lloyd Forcing	14	9	17	25	16	24	....	....	15.8	....	....
2	Blair Forcing	10	18	15	12	20	23	21	....	17.0	.9	1.46:1
	Lloyd Forcing	11	15	15	23	16	18	15	....	16.1	....	....
3	Blair Forcing	13	13	17	24	14	23	22	22	18.5	2.5	3.41:1
	Lloyd Forcing	13	11	11	17	15	22	17	22	16.0	....	....
		Total weight of fruits per plant in grams										
1	Blair Forcing	1 020	962	1 241	423	1 793	2 001	....	....	1 240.0	89.3	1:1
	Lloyd Forcing	1 053	573	1 268	1 570	1 083	1 357	....	....	1 150.7	....	....
2	Blair Forcing	414	1 367	1 016	1 422	1 522	1 386	2 092	....	1 317.0	....	....
	Lloyd Forcing	875	1 206	995	1 879	1 165	1 794	1 567	....	1 354.4	37.4	<1:1
3	Blair Forcing	816	1 018	790	1 804	1 081	1 659	1 480	1 930	1 322.2	176.0	2.26:1
	Lloyd Forcing	721	621	895	1 285	1 128	1 986	685	1 849	1 146.2	....	....
		Average weight of fruits per plant in grams										
1	Blair Forcing	60	60	59	53	94	83	....	....	68.1	....	....
	Lloyd Forcing	75	64	74	63	68	97	....	....	73.5	5.4	3.24:1
2	Blair Forcing	41	76	68	118	76	60	100	....	77.0	....	....
	Lloyd Forcing	80	80	66	82	73	100	104	....	83.6	6.6	1.46:1
3	Blair Forcing	63	78	46	75	77	72	67	88	70.8	1.2	<1:1
	Lloyd Forcing	55	56	81	76	75	90	40	84	69.6	....	....

of fact the authors have been unable to find a single variety that will withstand successfully the severe wilt conditions to be found in the bottom-heated benches.

FIG. 5.—A SEVERE ATTACK OF FUSARIUM WILT

The center plant shows a typical infection on the greenhouse benches, tho the plants on each side are healthy.

A comparison between Blair Forcing and Lloyd Forcing as to earliness of maturity is shown in Table 11. Blair Forcing is obviously somewhat earlier than Lloyd Forcing. The differences between the three series in time of maturity were due to the uneven distribution

TABLE 11.—COMPARATIVE EARLINESS OF BLAIR FORCING AND LLOYD FORCING TOMATOES: FALL OF 1929

(Percentage of total crop matured at each picking[1])

Date of picking	Series 1		Series 2		Series 3	
	Blair	Lloyd	Blair	Lloyd	Blair	Lloyd
Nov. 18	9.78	.....	.....	.....	.....	.....
Nov. 23	13.25	11.40	.....	.....	.....	.....
Nov. 29	11.43	10.46	15.58	11.62	7.96	8.38
Dec. 3	18.18	7.61	6.52	1.81	5.52	4.43
Dec. 9	23.91	13.67	17.17	15.83	13.20	18.74
Dec. 16	15.18	13.43	17.74	16.60	30.63	16.52
Dec. 23	8.27	26.28	23.99	26.77	15.93	29.81
Dec. 30	.....	17.16	19.00	27.38	26.76	22.13

[1]Total percentage harvested = 100.

TABLE 12.—YIELDS PER PLANT OF BLAIR FORCING AND LLOYD FORCING COMPARED WITH MARGLOBE AND GRAND RAPIDS FORCING: SPRING CROP OF 1930

Variety	Series 1				Series 2				Series 3				Mean			
	Firsts		Culls		Firsts		Culls		Firsts		Culls		Firsts		Culls	
	No.	*oz.*	*No.*	*oz.*	*No.*	*oz.*	*No.*	*oz.*	*No.*	*oz.*	*No.*	*oz.*	*No.*	*oz.*	*No.*	*oz.*
Lloyd Forcing	35.7	156.15	5.9	15.52	39.1	168.62	6.7	18.37	43.6	189.38	5.6	15.33	39.5	171.39	6.1	16.41
Grand Rapids Check	28.6	93.38	14.7	24.82	34.3	105.04	12.5	23.01	37.2	121.97	12.1	24.33	33.4	106.80	13.1	24.05
Increase over check	7.1	62.77	−8.8	−9.30	4.8	63.58	−5.8	−4.64	6.4	67.41	−6.5	−9.00	6.1	64.59	−7.0	−7.64
Percent increase	24.8	67.2	−59.9	−37.5	14.0	60.5	−46.4	−20.2	17.2	55.3	−53.7	−37.0	18.3	60.5	−53.4	−31.8
Odds														1439:1		
Lloyd Forcing	35.7	156.15	5.9	15.52	39.1	168.62	6.7	18.37	43.6	189.38	5.6	15.33	39.5	171.39	6.1	16.41
Marglobe check	29.3	152.87	2.6	5.62	29.1	142.58	3.7	7.41	26.2	140.21	2.5	4.87	28.2	145.22	2.9	5.97
Increase over check	6.4	3.28	3.3	9.90	10.0	26.04	3.0	10.96	17.4	49.17	3.1	10.46	11.3	26.17	3.2	10.44
Percent increase	21.8	2.2	126.9	176.2	34.4	18.3	81.1	147.9	66.4	35.1	124.0	214.8	40.1	18.0	110.3	174.9
Odds														4.33:1		
Blair Forcing	41.2	153.47	7.7	16.36	41.9	168.79	4.9	10.16	43.5	162.78	9.2	16.74	42.2	161.68	7.3	14.42
Grand Rapids Check	30.2	100.86	13.3	24.29	37.2	121.97	12.1	24.33	39.1	118.71	16.0	28.13	35.5	113.85	13.8	25.58
Increase over check	11.0	52.61	−5.6	−7.93	4.7	46.82	−7.2	−14.17	4.4	44.07	−6.8	−11.39	6.7	47.83	−6.5	−11.16
Percent increase	36.4	52.2	−42.1	−32.6	12.6	38.4	−59.5	−58.2	11.2	37.1	−42.5	−40.5	18.9	42.0	−47.1	−43.6
Odds														244:1		
Blair Forcing	41.2	153.47	7.7	16.36	41.9	168.79	4.9	10.16	43.5	162.78	9.2	16.74	42.2	161.68	7.3	14.42
Marglobe check	29.1	142.58	3.7	7.41	26.2	142.10	2.9	6.05	28.3	146.15	3.2	6.31	27.9	143.61	3.3	6.59
Increase over check	12.1	10.89	4.0	8.95	15.7	26.69	2.0	4.11	15.2	16.63	6.0	10.43	14.3	18.07	4.0	7.83
Percent increase	41.6	7.6	108.1	120.8	59.9	18.8	69.0	67.9	53.7	11.4	187.5	165.3	51.2	12.6	121.2	118.8
Odds														12.2:1		

of the heat, as explained before. Series 1, the earliest, was located at the eastern end of the house and Series 3 farthest west.

In solidity of fruit, evenness of ripening, freedom from cracking and smoothness, Blair Forcing is very much like Lloyd Forcing. Blair Forcing, however, appears to develop an abscission zone somewhat earlier, thus facilitating picking, but this development is not so premature that the fruits drop off before they are picked.

TESTS OF NEW VARIETIES IN SPRING OF 1930

Blair Forcing and Lloyd Forcing were given a final test in comparison with Grand Rapids Forcing and Marglobe in the spring of 1930. Another selection, not heretofore mentioned, was included in the test. This is designated as No. 1001 because it has been selected out of that cross number (Marglobe X Grand Rapids). Owing to its high yield and globe-shaped type No. 1001 may eventually prove very desirable, but it does not as yet reach the standard required.

TABLE 13.—BLAIR AND LLOYD FORCING COMPARED WITH MARGLOBE AND GRAND RAPIDS FORCING IN SIZE OF FRUITS CLASSED AS FIRSTS AND IN RATIO OF GREEN FRUITS LEFT ON VINES AFTER PICKING TO TOTAL YIELD OF RIPE FIRSTS (BY WEIGHT): SPRING CROP OF 1930

Variety	Series 1		Series 2		Series 3		Mean	
	Mean size of fruits	Ratio green fruits to ripe	Mean size of fruits	Ratio green fruits to ripe	Mean size of fruits	Ratio green fruits to ripe	Mean size of fruits	Ratio green fruits to ripe
	oz.		oz.		oz.		oz.	
Lloyd Forcing.	4.37	1:67.6	4.31	1:26.3	4.34	1:16.5	4.25	1:36.8
Grand Rapids.	3.26	1:43.2	3.06	1:14.4	3.28	1:13.6	3.20	1:23.7
Increase....	....	.....	....	.....	....	.....	1.05	1:13.1
Lloyd Forcing.	4.37	1:67.6	4.31	1:26.3	4.34	1:16.5	4.25	1:36.8
Marglobe.....	5.22	1:15.2	4.90	1: 9.5	5.35	1: 8.4	5.16	1:11.0
Increase....	....	.....	....	.....	....	.....	— .91	1:25.8
Blair Forcing..	3.72	1:79.1	4.03	1:62.7	3.74	1:39.8	3.83	1:60.5
Grand Rapids.	3.34	1:19.3	3.28	1:13.6	3.04	1:12.2	3.22	1:15.0
Increase....	....	.....	....	.....	....	.....	.61	1:45.5
Blair Forcing..	3.72	1:79.1	4.03	1:62.7	3.74	1:39.8	3.83	1:60.5
Marglobe.....	4.90	1: 9.5	5.42	1: 8.1	5.16	1: 6.8	5.16	1: 8.1
Increase....	....	.....	....	.....	....	.....	−1.33	1:52.4

The plot layout is shown diagrammatically in Table 14. There were 32 plants in each plot and three replications of plots, which are called series in Tables 12 and 13. Blair Forcing and Lloyd Forcing were planted so that a Marglobe check was adjacent to one side and a Grand Rapids check adjacent to the other. The yield data appear in Table 12.

Superiority of New Varieties Shown by High Spring Yields

Both Blair Forcing and Lloyd Forcing outyielded Grand Rapids, the increases being significant according to the odds, which were calculated on the basis of Student's method (Table 12). Blair Forcing and Lloyd Forcing gave only a slight increase in yield over Marglobe.

FIG. 6.—GRAND RAPIDS FORCING ON THE LEFT AND LLOYD FORCING ON THE RIGHT

These plants were adjacent to each other in the tests made during the spring of 1930.

It is interesting to note that both these varieties also produced a larger number of fruits than either Grand Rapids or Marglobe. Both Blair Forcing and Lloyd Forcing produced fewer culls than Grand Rapids and more than Marglobe.

The average weights of the fruits which were classed as "firsts" are shown in Table 13. The fruits of Blair Forcing proved to be .61 ounce larger than Grand Rapids and 1.33 ounces smaller than Marglobe. The Lloyd Forcing fruits were 1.05 ounces larger than

Grand Rapids and .91 ounce smaller than Marglobe. Thus both Blair Forcing and Lloyd Forcing proved to be intermediate in size between Marglobe and Grand Rapids. However, Blair Forcing is somewhat smaller than Lloyd Forcing.

New Varieties Superior for Fall Forcing

The performance of a variety in the spring is by no means a criterion of its yields in the fall. Lloyd Forcing, however, proved to be considerably more consistent in its performance in the fall and spring than either Marglobe or Grand Rapids. The following results are taken from Tables 7, 12, and 13.

Mean size of fruits

	Fall	Spring
	oz.	*oz.*
Lloyd Forcing	3.16	4.25
Grand Rapids	2.10	3.21
Marglobe	2.94	5.16

Mean yield per plant

	Fall	Spring
	oz.	*oz.*
Lloyd Forcing	78.81	171.39
Grand Rapids	38.34	110.32
Marglobe	50.26	144.42

Marglobe fruits in the fall proved to be approximately one-half as large as the fruits of the spring crop. Grand Rapids fruits were about two-thirds as large. On the other hand, the fall fruits of Lloyd Forcing were 75 percent as large as the spring fruits.

In mean yield per plant Marglobe and Grand Rapids produced only about one-third as large a yield in the fall as in the spring. In contrast, the fall yield of Lloyd Forcing was nearly 50 percent as large as the yield obtained in the spring.

On the basis of these comparisons it is evident that Lloyd Forcing is much better suited to year-round growth in the greenhouse than either Marglobe or Grand Rapids. Since Blair Forcing, both in the fall and in the spring, yielded about the same as Lloyd Forcing (Tables 10 and 12), it may be assumed that the two varieties are equally suitable for fall and spring forcing in the greenhouse.

New Varieties Mature Early

The 1930 spring yields of Blair Forcing have been plotted in Fig. 7 in terms of percentage of the total crop picked in each weekly period. Lloyd Forcing has been plotted in Fig. 8.

Both Blair Forcing and Lloyd Forcing are strikingly similar to

Grand Rapids in earliness of maturity. Marglobe lagged behind consistently until the week of June 2 to 7, but between June 2 and 14 it gave a larger yield. This is somewhat different from its performance in the fall as shown in Table 8. In the spring, therefore, Blair Forcing

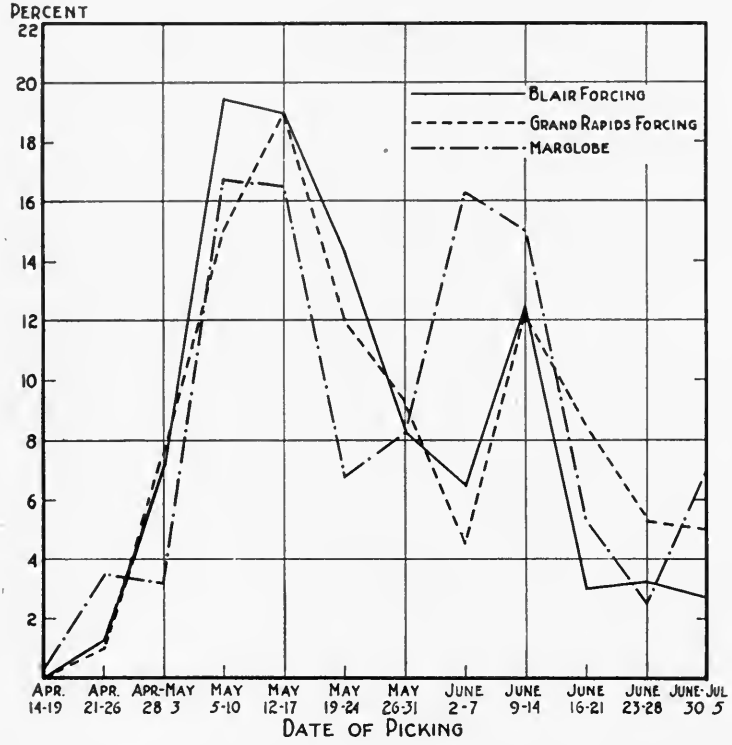

FIG. 7.—COMPARISON OF PERCENTAGE OF TOTAL CROPS OF BLAIR FORCING, MARGLOBE, AND GRAND RAPIDS MATURING IN WEEKLY PERIODS

Blair Forcing proved to be earlier than either Grand Rapids Forcing or Marglobe.

and Lloyd Forcing may be expected to mature earlier than Marglobe, thus assuring the grower the advantage of higher prices prevailing early in the season.

New Varieties Mature Large Proportion of Fruits

Blair Forcing and Lloyd Forcing have the ability to mature a greater proportion of the crop than either Grand Rapids or Marglobe. This is shown by the ratios in Table 13.

It is interesting to note that Blair Forcing is more efficient in ma-

turing its crop than Lloyd Forcing. Both varieties, however, are much superior to Grand Rapids in this respect. Marglobe lags very far behind. In fact if Marglobe were able to mature its entire crop within a reasonable period, it would probably outyield the others. This lag-

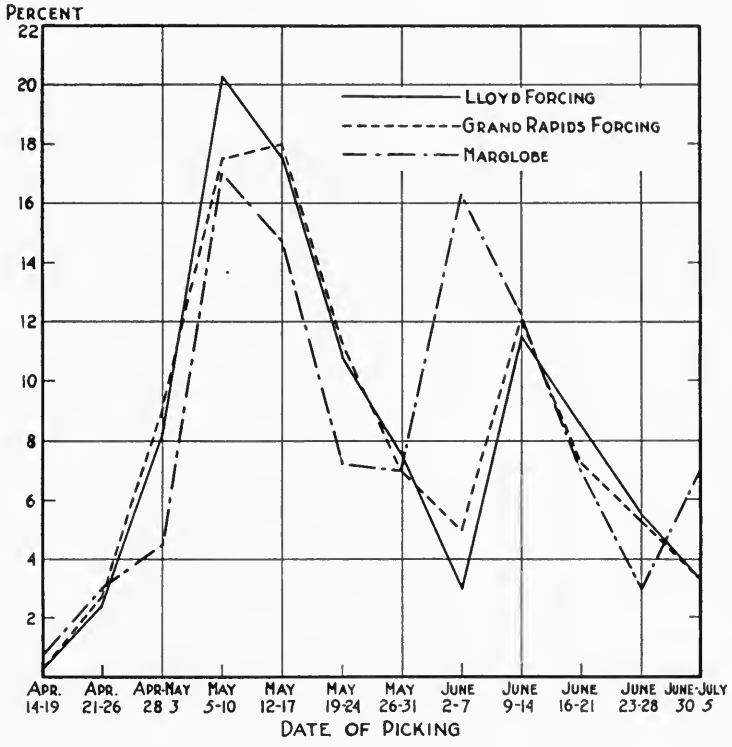

FIG. 8.—COMPARISON OF PERCENTAGE OF TOTAL CROPS OF LLOYD FORCING, MARGLOBE, AND GRAND RAPIDS MATURING IN WEEKLY PERIODS

Lloyd Forcing proved to be earlier than either Grand Rapids Forcing or Marglobe.

ging on the part of Marglobe is objectionable to the grower because field-grown tomatoes begin to compete early in July with those grown under glass, and prices fall very rapidly. Even tho no heat is necessary in July, nevertheless the cost of watering, constant pruning, etc., render it questionable whether a variety such as Marglobe would pay as well as one which matures more rapidly. Quick maturity minimizes the cost and assures an earlier market. Blair and Lloyd Forcing both approach this ideal much more closely than Marglobe.

Blair Forcing More Resistant to Wilt

A diagram of the occurrence of wilt in the spring-planted plots is shown in Table 14. These records were taken July 14, 1930, after the crop had been removed. Each plant was cut off at the ground level and inspected carefully for the appearance of the blackened vascular bundles characteristic in wilted plants.

TABLE 14.—PLOT LAYOUT OF YIELD TESTS IN SPRING OF 1930 SHOWING OCCURRENCE OF FUSARIUM WILT INFECTION

Plot	Variety	Plot Nos. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 (Condition of plants[1])	Plants infected but not killed	Plants dead	Total plants infected
			perct.	*perct.*	*perct.*
1	Grand Rapids...	i i d i 0 0 0 i d 0 0 i i i 0 0 i 0 i d i 0 d d d 0 0 0 d d i i	37.5	25.0	62.5
2	Lloyd Forcing...	0 i 0 0 d 0 0 0 0 0 0 0 0 0 0 i 0 i 0 0 0 0 0 d i i 0 i 0 0 i 0	21.9	6.2	28.1
3	Marglobe.....	0 0 0 0 0 0 0 i i 0 i i 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	12.5	0	12.5
4	No. 1001.....	i i 0 0 0 0 i 0 0 0 0 0 0 0 0 0 0 0 0 0 0 i 0 0 0 0 0 0 0 0 0 0 0	12.5	0	12.5
5	Grand Rapids...	0 0 0 i d 0 0 0 0 0 0 i i d 0 0 i i i 0 i 0 0 d 0 0 0 0 0 i d	25.0	12.5	37.5
6	Blair Forcing...	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	0
7	Marglobe.....	0 0 0 0 0 0 0 0 0 0 0 0 i 0 0 0 0 0 0 0 0 i i i 0 0 0 d 0 0 0 0	12.5	3.1	15.6
8	Lloyd Forcing...	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	0
9	Grand Rapids...	0 0 0 0 i d d i 0 0 0 0 0 0 i d i 0 0 0 0 0 d d 0 0 0 0 i i 0 0	18.8	15.6	34.4
10	No. 1001.....	0 d d i 0 0 0 0 0 0 i i d i d 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	12.5	12.5	25.0
11	Marglobe.....	i 0 0 0 i 0 0 0 0 0 0 0 0 0 0 0 i i i i 0 i 0 i i 0 0 0 0 0 0 0	28.1	0	28.1
12	Blair Forcing...	0 0 0 0 i 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 i 0 0	6.2	0	6.2
13	Grand Rapids...	0 i 0 0 d d 0 0 0 0 0 d 0 0 0 0 0 0 0 0 0 0 0 0 0 0 i i 0 0 0	9.4	9.4	18.8
14	Lloyd Forcing...	0 0 0 i 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 i 0 0 0 0 0 d i d 0 0	9.4	6.2	15.6
15	Marglobe.....	0 0 d i i i 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 i 0 i 0 0 0 0 0 0 0 0	15.6	3.1	18.7
16	No. 1001.....	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	0
17	Grand Rapids...	i d 0 i 0 0 0 0 0 0 0 0 0 0 0 0 i i 0 0 0 0 0 0 0 0 0 0 0 i 0 0	15.6	3.1	18.7
18	Blair Forcing...	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 i 0 i 0 0 0 0 0 0 0 0 0 0 0	6.2	0	6.2
19	Marglobe.....	i i 0 0 0 0 0 0 0 0 0 0 0 0 0 0 i 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	9.4	0	9.4

[1] i = infected; d = dead; and 0 = healthy.

Plants termed "infected" included a rather wide range. Many plants showed no other evidence of wilt than a partially or wholly discolored ring. Others had stem lesions and there was a more or less severe killing of leaves, which apparently did not affect the yields materially.

Dead plants were those which were so badly infected that premature death occurred.

The following results summarized from Table 14 indicate that Lloyd Forcing compares very favorably with Marglobe in respect to wilt-resistance and is very superior to Grand Rapids.

	Lloyd Forcing	Grand Rapids	Marglobe
Percentage of plants infected but not killed	10.4	21.9	13.5
Percentage dead	4.1	16.7	2.1
Total percentage infected	14.5	38.6	15.6

Similar data for Blair Forcing are given below:

	Blair Forcing	Grand Rapids	Marglobe
Percentage of plants infected but not killed	4.1	16.7	16.7
Percentage dead	0	8.3	1.0
Total percentage infected	4.1	25.0	17.7

Marglobe proved much more susceptible to wilt than did Blair Forcing, and Grand Rapids had six times as much infection. It is evident that Blair Forcing is considerably more wilt-resistant than Lloyd Forcing. The data from the bench greenhouse comparing the two varieties already mentioned lead to the same conclusion.

It should be understood that the authors do not claim that Blair Forcing and Lloyd Forcing are resistant to all strains of Fusarium wilt. Haymaker[5]* has shown that a considerable difference exists in the pathogenicity of various strains of Fusarium. He points out that there is also a certain selectiveness in plant resistance due to various soil temperatures. Accordingly, all wilt-resistant varieties may be expected to show considerable differences in resistance, depending upon temperatures and the virulence of the local strain of Fusarium.

It has been explained previously that the strain of Fusarium with which the greenhouses were infested came from Union county, Illinois. Wilt has been present for many years in that section and from the field performance of susceptible strains there, one would infer that the virulence is very high. Accordingly the authors expect both Blair Forcing and Lloyd Forcing to perform well under a wide range of conditions, especially because varieties which are resistant to a more virulent strain will also prove resistant to a lesser one, as shown by Haymaker.[5]* The reverse is not true, however.

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